STATEMENT OF FRANK VAN DEMARK, CHIEF OF THE SYSTEMS DEVELOPMENT DIVISION, FEDERAL AVIATION ADMINISTRATION BEFORE THE HOUSE PUBLIC WORKS AND TRANSPORTATION COMMITTEE, SUBCOMMITTEE ON OVERSIGHT AND REVIEW, CONCERNING WEATHER PROGRAMS. MAY 20, 1981

Mr. Chairman, and members of the Subcommittee, I am Frank Van Demark, Chief of the Systems Development Division, Systems Research and Development Service, Federal Aviation Administration (FAA). With me are Fred Gilmore, Chief of Environmental Systems Division; Ken Hunt, Director of Flight Operations; and Robert Hale, Chief, Accident/Incident Analysis Branch, Air Traffic Service.

Before discussing FAA's weather related programs, let me begin by presenting the objectives of the R&D program as it relates to the National Airspace System (NAS). The NAS is composed of: (1) diverse users; (2) air traffic controllers/flight service specialists; (3) hardware/software systems for communication, navigation, radar, and air traffic control; and (4) procedures for all to follow. The impact of weather on aviation safety and system design is extremely complex.

The FAA is most concerned with providing timely advisories of hazardous weather to the controller, the specialist, and the pilot. To be meaningful, these advisories must be relevant to the user's location in the national air space at a particular point in time. Weather information is derived from various sources such as manual surface observations, pilot reports, weather radars, ATC radars, weather satellites, etc. The data must pass through many hands and many procedural actions, and there is always the one-on-one pilot/controller information transfer problem when extra pressures on both jobs may interfere with weather data dissemination. Timely weather advisories are not an easy task.

FAA has a number of programs specifically designed for weather, and others, though designed for other purposes, which can be used to aid our weather program. These programs, in general, were planned independently of findings by the National Transportation Safety Board (NTSB), although the Board's findings have provided reinforcement. The following is a synopsis of our programs.

The synopsis is structured to address programs ranging from these in implementation to those in the R&D phase. These programs are designed to improve weather data acquisition and data dissemination to operations personnel, and, most importantly, direct dissemination to the pilot, whether on the ground or airborne.

I. SYSTEMS IMPLEMENTATION

Systems of recent or current implementation include: Color Weather Radar Display, Leased Automation for Flight Service Stations (FSSs) and Automation for Flight Service Stations via a systems production contract, FAA's high speed data communications system called the National Airspace Digital Information Network (NADIN), and Low-Level Wind Shear Alert Systems.

A. COLOR WEATHER RADAR DISPLAY

The color weather radar display system provides weather contours and other weather data for use by meteorologists, controllers, and flight service station specialists. The agency currently has a program underway to equip center meteorologists and Flight Service Station flight advisory positions with the color weather radar displays. This equipment is scheduled to start delivery this fall. Similar displays will be added later at en route air traffic control radar positions. These systems will display six levels of intensity to isolate areas of severe weather activity. Each level of weather will be indentified by a distinct color.

B. AUTOMATION FOR FSS SPECIALISTS

Leased automation now in place at FSSs is a preview of the full automation that the FSS specialist will have with implementation via an automation production contract to be awarded in a few months.

The leased systems now in place meet a recognized need to speed up weather data transmissions to the FSSs. During periods of bad weather across the country, our low speed weather switch and distribution systems could not get all the data to each FSS in the update period. Based on work done by the FAA's Air Traffic Service with Western Union at the DuPage FSS, we found we could acquire a high speed capability via lease arrangement with the operational device in place in a very short period of time.

While the leased system provides high speed access to weather data, the buy program will provide the specialist with a more flexible and complete weather briefing capability, including graphics from the National Weather Service, flight plan filing, and increased system capacity to meet the projected 1995 demand, which includes capacity for pilot self-briefing addressed later in this statement. These systems are expected to be delivered over a 5 year period beginning in 1982. Our plans are to install 23 computer systems, one at each ARTC center, with alpha-numeric and graphic displays at automated FSSs.

C. IMPROVEMENTS FOR THE CENTER METEOROLOGIST

Leased automation is under consideration for the center meteorologist to provide the capability for a fast, reliable means of putting pilot reports and meteorologist generated messages on Service A. It would have the ability to receive national weather data at high speed from the Kansas City weather switch.

D. DATA COMMUNICATIONS

The economics of data communications within the NAS via separate, dedicated networks, subject to rate increases and circuit use inefficiencies, has led FAA to commence a program to combine these separate networks into a single shared data network, the National Airspace Digital Interchange Network (NADIN). NADIN will provide high speed weather data and message communications among FAA, the National Weather Service, and Air Weather Service. It is also designed for communications among facilities for collection and dissemination of weather observations and weather radar data within FAA. The system is expected to be in national operation by mid 1983.

E. LOW-LEVEL WIND SHEAR ALERT SYSTEM

The agency is currently in the fourth year of a 6-year program to install low-level wind shear alert sytems. Fifty-Eight systems are currently under contract or installed. This is a system that detects the presence of a possible hazardous low-level wind shear by computer comparison of the winds around the periphery of an airport and the winds measured at the center of the field. If the computer detects a predetermined difference between the peripheral and centerfield wind, the tower controller is alerted.

II. WEATHER RELATED RESEARCH AND DEVELOPMENT

Our primary thrust is to adapt current and new ATC systems to better satisfy user requirements for weather products. In the case of the Next Generation Weather Radar (NEXRAD), Terminal Weather Radar and Automated Weather Observation System, we are devoting our R&D resources specifically to the measurement of weather phenomena. In addition, projects such as Automated Route Forecast (ARF) for Pilots and FSSs , Pilot Self Briefing via FSS Automation, and new ATC systems, are programs generated for other reasons that will also benefit aviation safety as related to weather.

A. DOPPLER RADAR APPLICATION

Development of a Next Generation Doppler Weather Radar is being pursued jointly with the NWS, and the USAF (Air Force Geophysics Laboratory and Air Weather Service), to establish in the late 1980s a national weather radar network to meet common weather data requirements. However, FAA ATC terminal weather requirments in terms of coverage, data rates, resolution, accuracy, and false alarm rate are substantially more demanding than those identified by NWS and AWS and are, therefore, being further investigated by FAA. One example is the assembly of a transportable Doppler weather radar unit in the 1984 timeframe.

This summer we will be using a weather radar unit of the Massachusetts Institute of Technology to collect data since our transportable unit will not be available until the summer of 1982. These data are needed to validate the need for terminal weather radar.

Joint efforts with AWS and NWS include turbulence measuring test flights at the National Severe Storms Laboratory to determine the correlation between aircraft encountered weather and the hazards detected by Doppler radars. We are also participating with the National Oceanic and Atmospheric Administration, the National Aeronautics and

Space Administration, and the National Science Foundation in an effort in 1982 in the Denver, Colorado, area directed toward perfecting terminal weather radar siting criteria; validating weather radar update and accuracy requirements; and analyzing wind shear profile and thunderstorm outflow (downbursts) effects on terminal ATC operations.

Two aspects of airborne Doppler radar are also under investigation--first, the performance under storm conditions this summer using FAA flight check aircraft in Oklahoma; and second, in cooperation with NASA, we are investigating in 1981 and 82 attenuation due to water and ice on the radome.

B. MODULAR AUTOMATIC WEATHER SENSOR SYSTEMS

An FAA/NWS program, begun in the early 1970's, resulted in an automatic weather sensing and reporting system. A computer generated voice speaks the temperature, dew point, wind, altimeter, and density altitude. The modular design permits up-grading to more complex systems by adding additional sensors and data processing, e.g., measurement of ceiling and visibility. The FAA, with NWS cooperation, began testing such a system at Dulles International Airport in October 1980. A similar system adapted to the oil rig environment will be operationally tested on an offshore platform starting this month. This system also includes sensors for lightning detection and tracking as precursors of thunderstorms where we do not have weather radar coverage. Output from weather sensors is fed to a computer that converts the parameters to voice which is then transmitted through a VOR or other radio frequency to aircraft in the area. Commercially available systems have already been employed at non-ATC airports.

With the addition of automated reporting of up-to-date weather (i.e., rain, snow, sleet) in 1983, these systems will be suitable for FAA needs at airports having instrument approaches but no weather observers. These systems also include the means for direct pilot access via phone and radio. To achieve even more utility, we have underway system tests and evaluations leading to airport sponsor acquisition of commercially available automated weather observation systems that also include direct pilot access features.

Carrying all this a step further, the FAA has just assumed the role of Program Manager for an automated weather observation system program in the common interests of the Departments of Transportation, Defense, and Commerce.

C. AUTOMATED ROUTE FORECASTS (ARF)

Forecasts today are generated for large geographic areas and for defined routes of flight--a very labor intensive activity for NWS and FAA in the generation, update and transmission of these forecasts. The Automated Route Forecast is a detailed computer-generated aviation forecast for specific routes requested by pilots. It is a joint FAA/National Weather Service effort. All information required for the forecasts is placed in the computer in a nationwide grid form. The system will provide viewable, quantified, local weather data such as NOTAMS (notices to airmen), Pilot Reports (PIREPs), density altitudes, etc. The program is jointly funded and staffed by FAA and NWS for the purpose of promoting operational efficiencies to both organizations, as well as better service to the pilot. Plans for implementation are now being formulated.

D. COMPUTER GENERATED AUTOMATIC TERMINAL INFORMATION SERVICE (CG-ATIS)

At present, manually derived weather and aeronautical data are broadcast in airport terminal areas from 30-second tape recordings. We have developed a system that provides computer generated voice broadcasts of automatically derived surface weather data and ATC manually inserted messages. The system is under test at Buffalo, New York. The computer converts weather information to voice, which is transmitted over the VOR or other outlets to aircraft. This same technology is applicable to the automatic generation and update of hazardous weather advisories and aeronautical data provided to pilots via telephone and radio broadcasts over navigational aids, FAA services referred to as Pilot Automatic Telephone Weather Answering Service (PATWAS) and Transcribed Weather Broadcasts (TWEB).

E. PILOT SELF-BRIEFING VIA INTERIM VOICE RESPONSE SYSTEM (IVRS)

The FSS Automation Program includes a computer-controlled voice response system (VRS) and direct pilot access to our FSS computer system and weather data base via telephone.

Presently functioning in a test/public demonstration configuration in the Washington, D.C., and Columbus, Ohio, areas, is a VRS that enables pilots to receive a limited automated weather briefing by using a push-button telephone. A computer-generated voice responds to the push-button signals and provides selected Surface Observations, Terminal Forecasts, Forecast Winds Aloft for specific en route locations, Convective SIGMETS, and Alert Weather Watches. Our next product will be local weather briefings for over 80 locations throughout the U.S.

Acoustically-coupled tone signalling devices can also be used to allow access to the VRS over non-push-button telephones. In all designs the weather data base is automatically updated as new data becomes available, in order to make sure that the pilot has access to the most current information.

F. PILOT SELF BRIEFING VIA FSS AUTOMATION

VRS is not the only pilot direct access method being developed by the FAA. Commercially available computer terminals, with the capability to provide pilots with a visual display, hard-copy, or both can be used to allow access to our FSS computers to obtain weather and aeronautical data. A test/public demonstration at Windsor Locks, Connecticut later this year will include such terminal devices. We envision that direct access via home computers or devices utilizing television sets for display will eventually extend self-briefing capability into user homes and offices. We expect that the self briefing capability will follow FSS automation by about a year and a half.

G. CONCENTRATION OF FAA WEATHER DATA MANAGEMENT IN FSS AND CWSU AUTOMATION

FAA weather data bases will be at two centralized sites (Atlanta and Salt Lake City) as part of the FSS automation program and distributed to FSS automation computers located at the ARTC centers. The intent is to focus all FAA weather data management in these computer facilities, and, through the center meteorologist, provide weather services to all our en route and terminal ATCs as well as FAA's flight information service.

The principal job of the Center Meteorologist is to monitor weather events in real-time and disseminate information on these events to controllers and users as quickly as possible. We feel that the Meteorologist's ability to do this job would be greatly enhanced by automation. Due to the differing nature of the meteorologist and FSS specialist jobs, the FSS systems will require some change. We are now initiating an activity at the Test Center to evaluate automation for the Center Meteorologist.

F. AUTOMATED WEATHER OBSERVATIONS FROM AIRCRAFT

Expansion of the national weather data base through weather sensors on-board selected aircraft to measure temperature, winds, icing, etc., with automated data collection/

dissemination to the ground would be desirable. However, costs of data collection and processing relative to space positioning and determination of relative value for ATC advisories have not led to any obvious design conclusion. At this point, the FAA with NWS and others are in a study phase.

H. WIND SHEAR

From August 1975 through 1980, we concentrated on three primary areas to assist pilots in either avoiding shear or helping them to safely recover from a shear encounter. First, with only rare exceptions, the shear that has caused the accidents of the 1970's is almost totally associated with the air-outflows from thunderstorms. We, therefore, sought to develop ground-based instrumentation to detect, measure, and track hazardous shear zones that develop from thunderstorms. We tested a number of ground-based shear measurement techniques and systems in conjunction with NASA. We also gained an understanding of the nature of the mechanisms that cause shear conditions and the effect strong shears have on aircraft performance and control; evaluated airborne aids that might help pilots cope with shear encounters; and, in conjunction with the National Weather Service, explored techniques for forecasting low-level wind shear.

The ground-based devices tested to detect and measure low-level shear included: acoustic Doppler technology, multiple anemometers in the approach and departure zones, pressure-jump devices surrounding the airport, pulsed Doppler laser and finally, an area we are still exploring, a pulsed Doppler radar (NEXRAD). Only the multiple anemometer concept which evolved into the Low Level Wind Shear Alert System has been operationally implemented.

An extensive flight simulation effort was conducted in four phases using a DC-10 simulator at McDonald-Douglas Corp. Using hazardous wind shear profiles developed by the FAA from reconstructed accident meteorological data, many wind shear aiding concepts and procedures were evaluated. Subjects in this evaluation were line pilots from several air carriers, and engineering and test pilots from industry and the FAA. The aiding concepts determined to be most valuable in coping with hazardous wind shears of varying intensity were: 1) an airspeed/groundspeed procedure, 2) a modified flight director, and 3) an acceleration margin indicator.

In addition, from the results of related studies of the wind conditions encountered by aircraft, the FAA developed a set of ten low level wind profiles for use in pilot training programs. The profiles have been made available to both domestic and international air carriers.

In the wind shear forecasting area, the National Weather Service began issuing Low Level Wind Shear Advisories and forecasts in April 1979. Our plans for the future include data collection and analysis of shear profiles taken by multiple Doppler radars in a program known as the "Joint Airport Weather Studies Project", along with NASA, NOAA, and the National Science Foundation in the summer of 1982 near Denver, Colorado. Additionally, we will continue to monitor those industry developed commercial devices made available for use as airborne wind shear aids. An FAA flight check aircraft is equipped with such a device, and, as wind shears are encountered, the usefulness of the device will be evaluated. Finally, our work in developing a Doppler weather radar for wind shear detection and for use in the terminal area will continue through FY 1982 and beyond. Implementation of doppler radar technology is expected in the late 1980s.

I. COMMUNICATION WITH AIRCRAFT

Currently, controllers send and receive all information through voice radio communication with aircraft. Frequency utilization is strained at times, and, although additions are possible, the Agency cannot continually add controllers for one-on-one communciations. Electronic data link is being tested as an aid and supplement.

As a digital data link becomes available, rapid nonvoice communication with equipped aircraft will be possible. Many routine and high-priority messages will be transmitted. Weather related items proposed to be transmitted to the plane include hazardous weather advisories, routine weather data upon request, and route-oriented weather. In addition, data on weather collected from the aircraft will transmitted to the ground. The impact here is increased pilot awareness and safety, and less involvement of the controllers.

Our mission also includes services to general aviation nationwide. Avionics economics and airspace coverage will dictate alternative communciation links to serve general aviation. We are actively applying current technology to communicate, via VOR voice channel, digital radar data and weather data text messages to cockpit devices to speak or display information automatically, i.e., without the one-on-one human operation.

Request/reply Data Link has been through airborne tests using FAA's voice response system weather data base. These tests will continue at the Technical Center in 1982 and 1983. This summer, we will conduct airborne tests of the VOR voice channel link.

J. AVIATION WEATHER COLLECTION, PROCESSING, DISSEMINATION, AND DISPLAY VIA EN ROUTE ATC OF THE 1990's

We have underway supporting projects directed to new ATC (en route and terminal) display subsystems. These subsystems are in our long-range plans. At this time we are preparing for test and evaluation at FAA's Technical Center to demonstrate to our ATC personnel how these new systems will address operational requirements, including weather displayed as contours overlaying the ATC display presentation and alpha-numeric data and text on tabular displays.

K. AUTOMATIC CELL DETECTION AND TRACKING

Weather radars currently used for precipitation observation by the National Weather Service require manual, labor intensive interpretation to provide user desired products, e.g., the radar data are displayed as contour maps of reflectivity and must be subjectively analyzed to deduce regions of possible hazard.

Recent advances in weather radar system design include the application of digital data processing to data management, processing for display, transmission to remote displays, and archiving. Color displays readily show the reflectivity of an individual resolution element of the radar system, and color is easier to read than the earlier gray shade coded displays. The analysis of the current weather picture to provide the required hazard detection, warning, and forecast, which has been manual, will be replaced by a computer-based processing scheme (algorithm) that will automatically detect regions of possible hazard and provide short range (0-20 minute) forecasts of storm development and cell motion. The capability is currently under test and will be available for implementation by the mid-1980's.

L. ICING

The FAA, in coordination with other government agencies, is striving to overcome the critical effects of atmospheric icing on aircraft. In coordination with the U.S. Army, a Helicopter Icing Spray System has been developed. This simulated icing environment will be used in certifying aircraft for flights into icing conditions. In addition, data on the atmospheric icing environment is being obtained by the University of Wyoming under a contract with FAA in a cooperative effort with NASA, Naval Research Laboratory, U.S. Army, U.S. Air Force, and private aircraft companies. These organizations have equipped some aircraft to collect icing related data while in flight. To overcome the inadequacies of icing forecasts, an interagency plan is being developed under the direction of the Federal Committee for Meteorological Services and Supporting Research. The effort is aimed at detection of hazardous icing conditions, communication of the hazard, and improving the icing forcasting techniques.

M. PILOT REPORTS (PIREPS)

The solution to making PIREPS meaningful to FAA, NWS, and AWS and to establish an efficient and timely collection process is elusive.

Automated data collection from airborne aircraft is an attractive solution but too distant in time to be the panecea. Standardization of reports and message content for FAA/NWS/AWS exchange can be resolved. It is the method of collection and dissimination that, today, is labor intensive and overlays the pressures of IFR operations. Therfore, we are seeking ways within FAA's system to make the machine system work for controller and specialist.

In FSS automation, we are closer to doing this than in en route or terminal automation. The specialists will be able to call up on their displays a PIREP format for data entry followed by a simple keyboard action to enter the report. The computer will do the checking and dispatching.

At our Technical Center, we are investigating ways to use the system for en route and terminal PIREP handling. Lease automation for the center meteorologist offers some help.

That concludes my prepared statement, Mr. Chairman. At this time my colleagues and I would be pleased to answer any questions you or other members of the Subcommittee may have.